



RESEARCH DEPARTMENT

LONG DISTANCE PROPAGATION MEASUREMENTS OVER THE NORTH SEA AT 187 Mc/s

Report No. K-153

(1962/11)

**THE BRITISH BROADCASTING CORPORATION
ENGINEERING DIVISION**

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D.W. Taplin, Grad. I.E.E.
J.W. Stark, C.G.I.A., A.M.Brit.I.R.E.
S.J. Ashdown
I. Rhodes
Mrs. P.A. Gagan

W. Proctor Wilson .

(W. Proctor Wilson)

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Section	Title	Page
	SUMMARY	1
1	INTRODUCTION	1
2	TRANSMITTING AND RECEIVING SITES	1
	2.1. Transmitting Site	1
	2.2. Receiving Sites	2
3	RESULTS	4
4	VARIATION OF FIELD STRENGTH IN THE AREAS NEAR THE RECEIVING SITES . . .	7
	4.1. Site Variation Factor	7
	4.2. Variation of Field Strength with Increasing Distance Inland . . .	8
	4.3. Variation of Field Strength with Height of Receiving Aerial Above Mean Sea Level	8
5	COMPARISON OF BAND III OVERSEA RESULTS WITH THE RESULTS OF EARLIER EXPERIMENTS	11
	5.1. Comparison with Band II Over the Same Paths	11
	5.2. Comparison with Band III Overland Results	13
6	CONCLUSIONS	15
7	ACKNOWLEDGEMENTS	15
8	REFERENCES	15
	APPENDIX I	16
	APPENDIX II	18

April 1962

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LONG DISTANCE PROPAGATION MEASUREMENTS OVER THE NORTH SEA AT 187 Mc/s

SUMMARY

This report presents the results of field strength measurements of v.h.f. transmissions on 187 Mc/s over the North Sea at distances up to 591 miles (950 km). These measurements extended over a period of approximately 18 months from April 1957 to December 1958 and have been used in the preparation of field strength/distance curves for various percentages of the overall time.

The field strength/distance curves have been compared with those obtained from earlier measurements of v.h.f. transmissions overland on 180.4 Mc/s and of v.h.f. transmissions over the North Sea on 94.35 Mc/s.

1. INTRODUCTION

Very high frequency transmitters situated in the United Kingdom and on the Continent of Europe may have to share the same channels. When planning such common channel transmitters, information is required concerning the propagation of very high frequencies over long sea paths so that the distance between these stations is such that the mutual interference is kept to a minimum.

Long distance propagation tests over the North Sea were made by the B.B.C. in Band II¹ (94.35 Mc/s) from July 1954 to September 1955, with the active aid and co-operation of the Netherlands Postal and Telecommunications Services. As an extension of this work, long distance propagation measurements were made in Band III (187 Mc/s) over the North Sea from April 1957 to December 1958. These measurements followed the tropospheric propagation tests in Band III² over land paths. Both experiments were part of the B.B.C.'s contribution to Study Group V of the C.C.I.R.³

This report covers the measurements made on 187 Mc/s over the North Sea between April 1957 and December 1958.

2. TRANSMITTING AND RECEIVING SITES

2.1. Transmitting Site

The transmitter was installed at Scheveningen Radio Station and was operated on behalf of the B.B.C. Research Department by the Netherlands Postal and Telecommunications Services. Site details are given in Table 1.

TABLE 1

Transmitting Site Details

Location	Site Height Above Mean Sea Level		Aerial Height Above Ground Level		Latitude	Longitude
	ft	m	ft	m		
Scheveningen	44	13.5	150	46	52°06'N	04°16'E

The transmitter operated on a frequency of 187 Mc/s and was 100% square-wave modulated at a frequency of 1,000 c/s. The modulation was cut for two seconds every minute so that the signal could be identified at the receiving sites. The transmitting aerial, a four-element Yagi with a λ -square rod screen reflector, had an effective gain of 7.1 dB relative to a half-wave dipole, and gave an effective radiated power (e.r.p.) of 1,520 watts in the direction of maximum radiation (320° T.B.).

The transmitter started transmissions on 8th April 1957 and radiated daily from 09.00-23.00 hours, British Local Time. The only periods of failure were from 12th July to 9th August 1957 and from 31st January to 24th March 1958.

2.2. Receiving Sites

The type of receiver installed at each of the sites during this experiment has been described in detail in another Research Department report.⁴ The main features of the receiver are its high sensitivity and stability of calibration. The application of negative feedback gives an approximately logarithmic recording law and a signal range of the order of 50 dB is covered. When this range is insufficient (under anomalous conditions of the troposphere), a relay inserted in series with the recording milliammeter switches an attenuator into circuit between the radio frequency (r.f.) and intermediate frequency (i.f.) units. The attenuator is switched out of circuit at the end of the day's recording.

The receiving sites were those chosen for the Band II experiment,¹ giving transmission paths of from 123 miles (198 km) to 591 miles (950 km). Fig. 1 shows the geographical positions of the receiving sites and Table 2 the relevant data of each site.

The receiving sites were brought into operation as the receivers were installed. Recording began at the various sites as follows:

Happisburgh	10th April 1957
Flamborough Head	8th April 1957
Newton-by-the-Sea	10th April 1957
Bridge of Don	22nd May 1957
Lerwick	14th May 1957

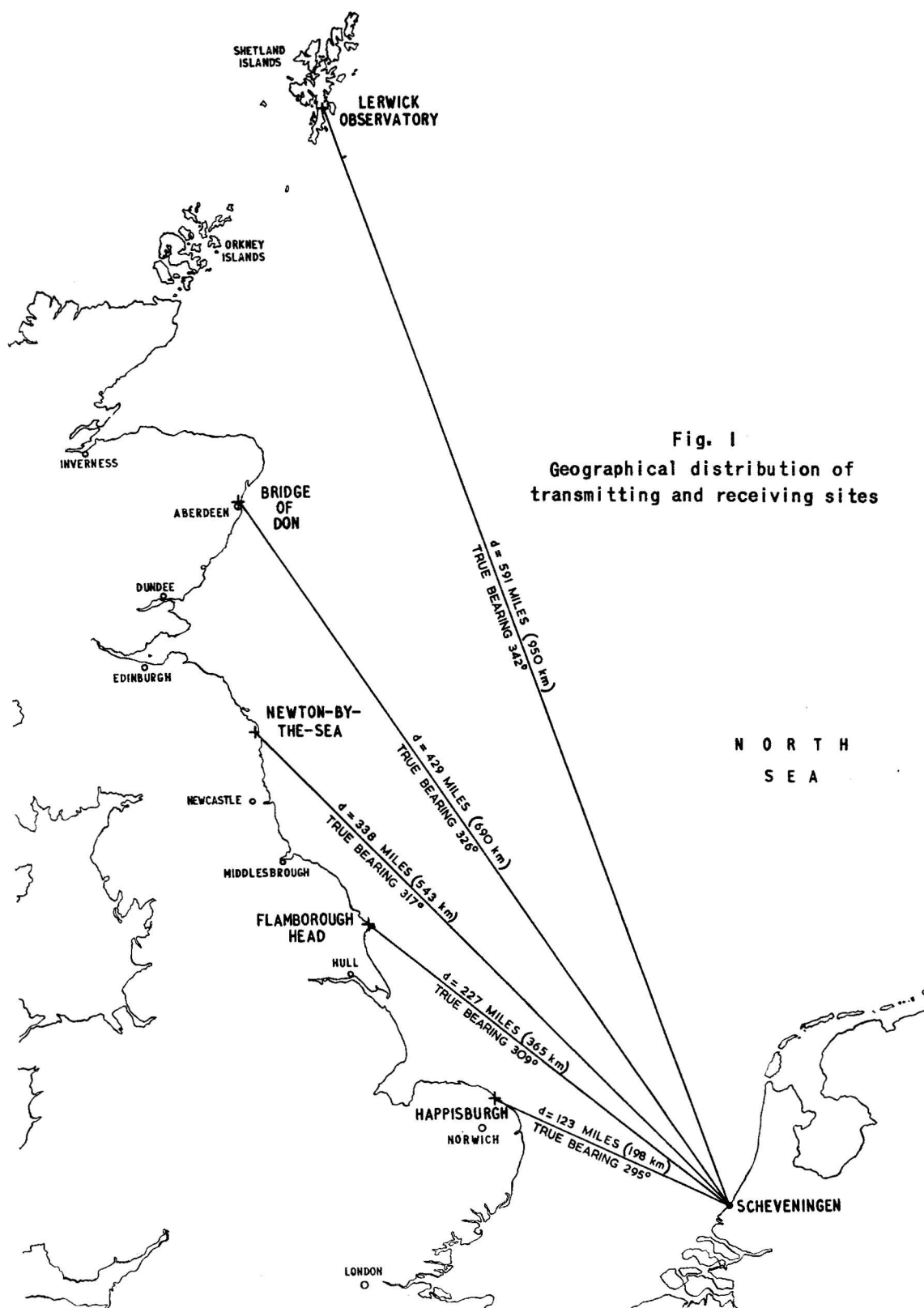


TABLE 2

Receiving Site Details

Location	Distance from Transmitter		Site Height (a.m.s.l.)		True Bearing of Site from Transmitter	Latitude	Longitude
	miles	km	ft	m			
Happisburgh	123	198	50	15.2	295°	52°49'42"N	01°31'38"E
Flamborough Head	227	365	150	45.7	309°	54°07'39"N	00°05'40"W
Newton-by-the-Sea	338	543	70	21.3	317°	55°31'06"N	01°37'05"W
Bridge of Don	429	690	30	9.1	326°	57°10'40"N	02°05'00"W
Lerwick	591	950	300	91.5	342°	60°08'00"N	01°10'20"W

3. RESULTS

Fig. 2 shows the results of the analysis of the measurements made at each of the sites, plotted as field strength exceeded against percentage of the total time. Tabulated results, appropriate to certain fixed percentage times, are given in Table 3. It will be noted that the curve for Newton-by-the-Sea is extrapolated to give both the 0.1% and 10% values. The receiver sensitivity was insufficient to record signals below the field strength level exceeded for 7% of the time. The switched attenuator mentioned in Section 2.2 had not been installed for the early months of the experiment and the abnormally high field strengths occurring in June 1957 were therefore off the scale of the recorder.

TABLE 3

Results

Receiver	Distance from Transmitter		Hours of Valid Recording	Field Strength, dB rel. to 1 μ V/m for 1 kW e.r.p.					
	miles	km		0.1%	1.0%	10%	50%	90%	99%
Happisburgh	123	198	6,380	54.0	43.0	28.0	14.0	1.0	-8.5
Flamborough Head	227	365	6,819	50.0	26.5	9.0	-1.0	-12.0	-
Newton-by-the-Sea	338	543	6,010	37.0*	10.0	-18.0*	-	-	-
Bridge of Don	429	690	6,752	27.5	1.0	-	-	-	-
Lerwick	591	950	6,845	22.0	-11.0	-	-	-	-

*Extrapolated

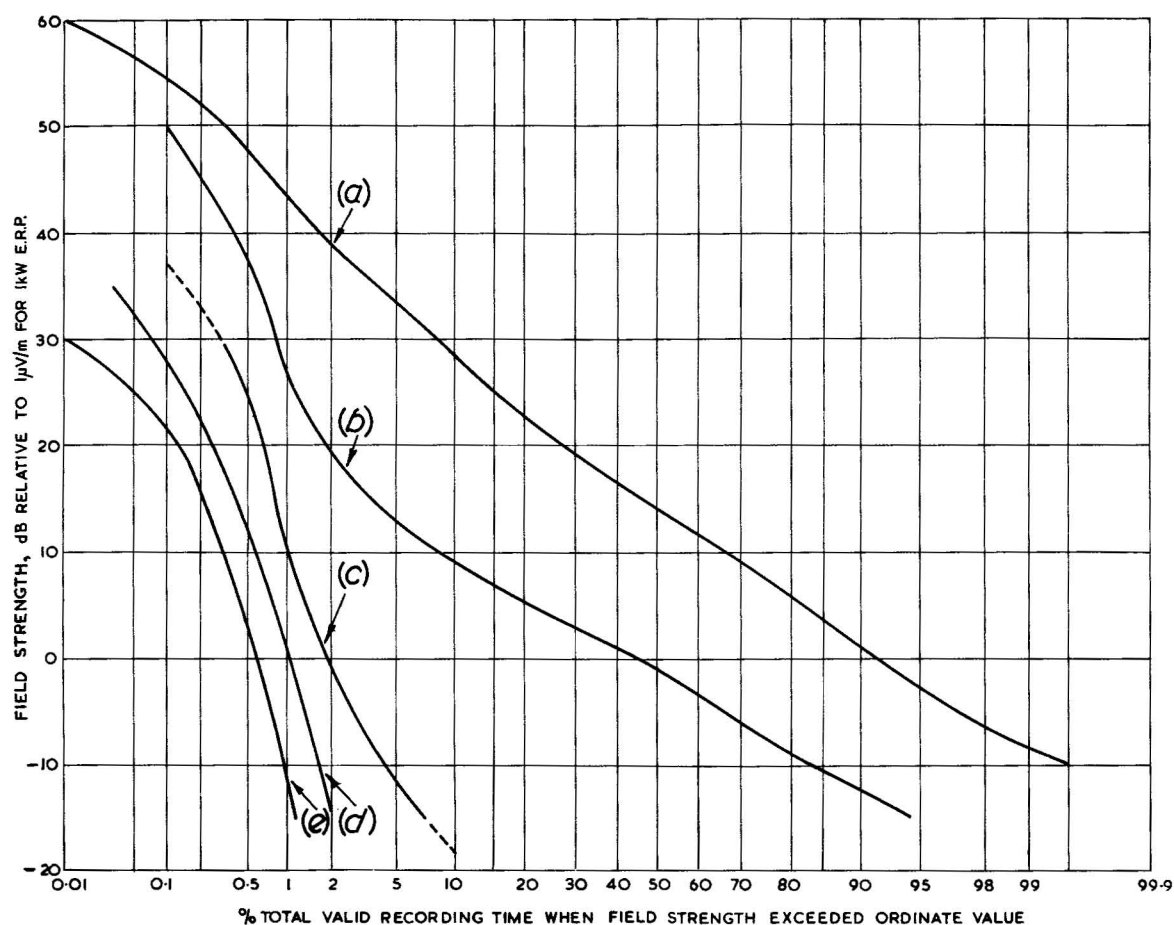


Fig. 2 - Band III overseas: variation of field strength with time

Curve	Site	Distance		Total Hours Recorded	Free Space Field
		miles	km		
(a)	Happisburgh	123	198	6,380	61.0
(b)	Flamborough Head	227	365	6,819	55.9
(c)	Newton-by-the-Sea	338	543	6,010	52.2
(d)	Bridge of Don	429	690	6,752	50.2
(e)	Lerwick	591	950	6,845	47.3

Values of field strength in dB relative to $1 \mu\text{V/m}$ for certain fixed percentage times are shown in Fig. 3 plotted against distance on a linear scale. The same values are shown in Fig. 4 plotted against distance on a logarithmic scale. Lines of best fit, calculated by the least squares method, are drawn for the 0.1%, 1% and 10% time values. It will be noted that the 10% time lines are derived from three measurements only.

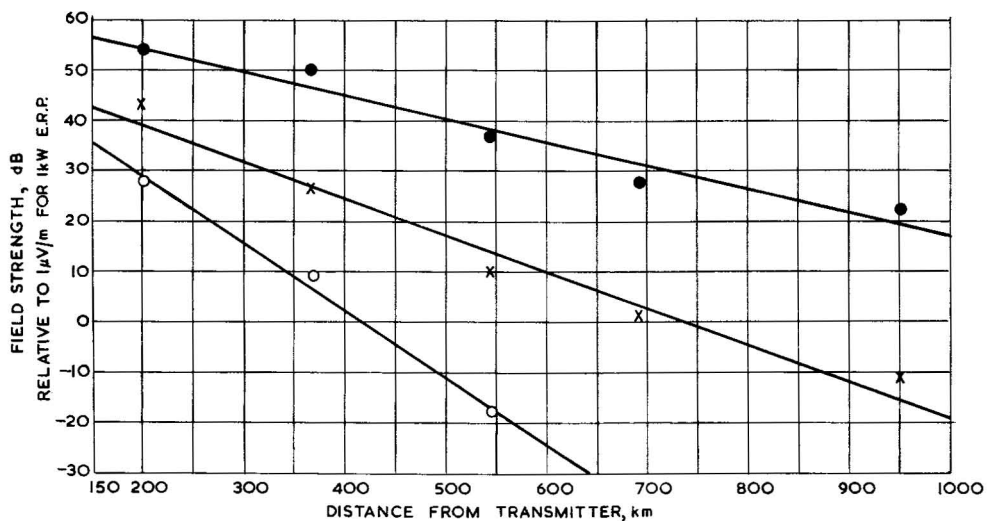


Fig. 3 - Band III overseas: variation of field strength with distance for fixed percentage times - exponential law

● = 0.1%
 X = 1%
 ○ = 10%

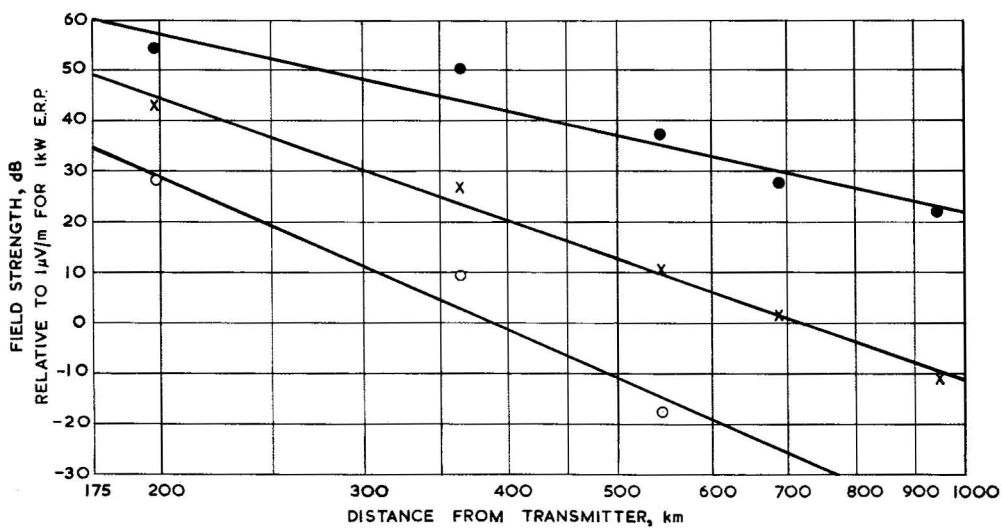


Fig. 4 - Band III overseas: variation of field strength with distance for fixed percentage times - inverse power law

● = 0.1%
 X = 1%
 ○ = 10%

The best fit lines and measured values shown in Fig. 4 have been redrawn in Fig. 5 on a linear distance scale, together with the C.C.I.R. field strength/distance curves adopted at the IXth Plenary Assembly, Los Angeles 1959, for the frequency range 40-600 Mc/s and for a transmitting aerial height of 60 m. It will be seen that the measured values are in excess of the C.C.I.R. curves at the greater distances by approximately 10 dB for 10% of the time and by 20 dB for 1% of the time. It will be recalled that the C.C.I.R. curves were derived from measurements over land and so the difference in field strength is that which can be expected if the propagation path is entirely over sea.

4. VARIATION OF FIELD STRENGTH IN THE AREAS NEAR THE RECEIVING SITES

4.1. Site Variation Factor

The fixed site measurements made during the Band III overland² experiments were corrected to give results typical of average receiving installations in their respective areas. For a fixed receiving site the correction applied, known as the "site variation factor" (s.v.f.) was estimated by choosing from 15 to 20 temporary sites within a radius of 5 miles (8 km) of the fixed site and comparing the measured field strengths with that at the fixed site. The ratio in decibels of the field strength at each of the temporary sites to that at the fixed site was found and the mean of the ratios for all the sites gave the s.v.f.

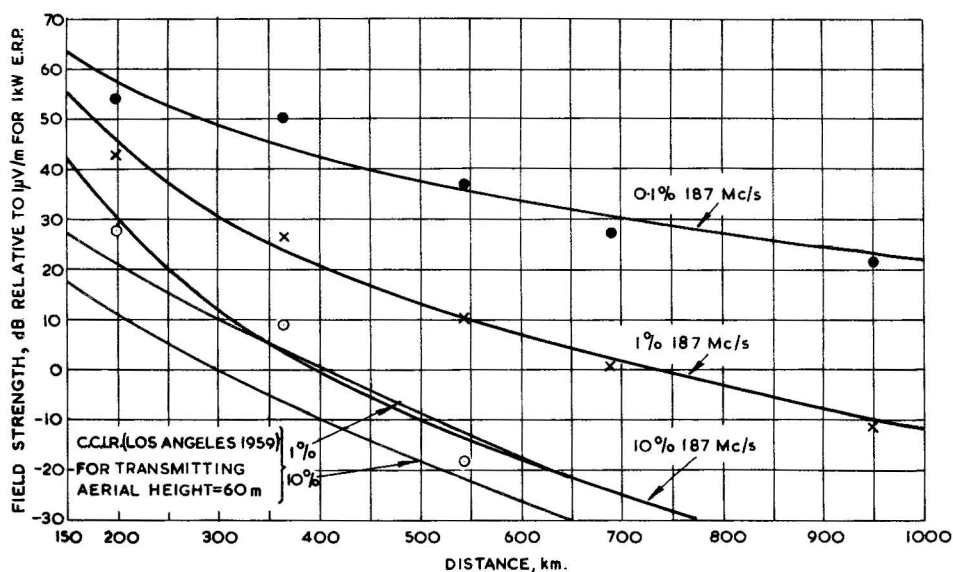


Fig. 5 - Comparison of Band III overseas field strength/distance curves with C.C.I.R. (Los Angeles 1959) curves

● = 0.1%
 X = 1%
 ○ = 10%

With this technique in mind, it may be expected that the field strength received near the coast can be influenced by the height of the receiving site above the sea level and by the local terrain. In fact, measurements made at sites near Happisburgh and Flamborough Head yielded s.v.f.s of -5.3 dB and -5.8 dB respectively. Details of these sites and the measurements are listed in Appendix I. As signals were received at Newton-by-the-Sea, Bridge of Don and Lerwick only during anomalous propagation conditions, measurements at neighbouring sites were impracticable and s.v.f.s could not be assessed for these sites.

It is of interest to note that the field strength received in average localities in the coastal strips behind the fixed sites Happisburgh and Flamborough Head is less than that received at the fixed sites by the same order, 6 dB, in spite of their differing heights above sea level. This suggests that the field strength to be expected at average receiving installations in the area adjoining the coast may be some 6 dB less than that given in Fig. 5 for the different percentage times.

4.2. Variation of Field Strength with Increasing Distance Inland

The s.v.f. measurements given in Appendix I have been plotted in Fig. 6 as field strength relative to that at the fixed site against distance inland in a direction away from the transmitter. Insufficient measurements have been made to give confidence in this curve but the results have nevertheless been included in this report to give an indication of the reduction in field strength to be expected with increasing distance inland.

4.3. Variation of Field Strength with Height of Receiving Aerial Above Mean Sea Level

The results obtained during site variation tests indicate at sites near the coast some increase in field strength with increase in aerial height above sea level. The measurements made at sites less than 0.5 mile (0.8 km) from the coast in the direction of the transmitter have been selected from Appendix I and are listed in Tables 4 and 5 for convenience.

TABLE 4

S.V.F. Measurements in the Happisburgh Area

Site No.	Distance from Coast in the Direction of Transmitter		Aerial Height Above Mean Sea Level		Comparison of Field Strength with that at Fixed Site
	miles	km	ft	m	
1	0	0	160	49	+3.0
Fixed Site	0.1	0.2	80	24	0
4	0.1	0.2	90	27	-1.5
6	0.1	0.2	60	18	-1.5
9	0	0	40	12	-3.0
14*	0.2	0.3	50*	15*	-7.0*

*Site obscured from the sea by obstacles.

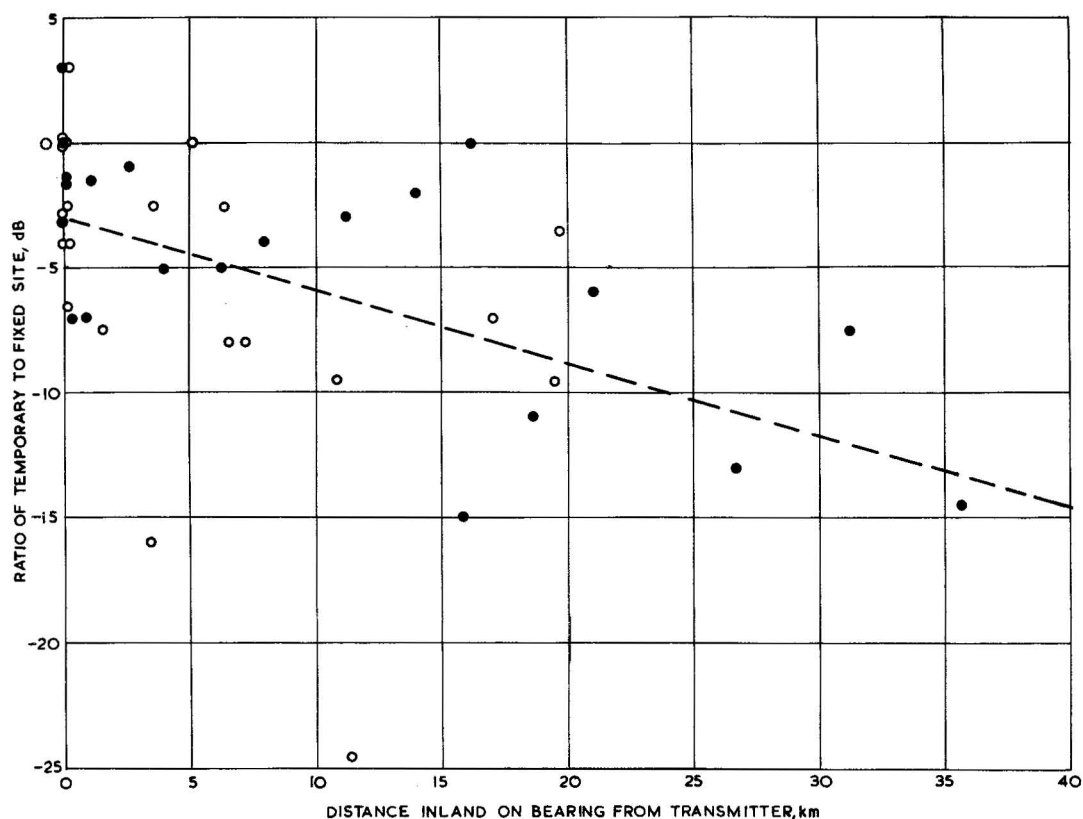


Fig. 6 - Variation of field strength (187 Mc/s) with distance inland after a long oversea path

● = Happisburgh area

○ = Flamborough area

TABLE 5

S.V.F. Measurements in the Flamborough Area

Site No.	Distance from Coast in the Direction of Transmitter		Aerial Height Above Mean Sea Level		Comparison of Field Strength with that at Fixed Site
	miles	km	ft	m	
1	0.3	0.5	180	55	+3.0
Fixed Site	0.2	0.3	180	55	0
2	0	0	130	40	0
4	0.1	0.2	100	30	0
5*	0.1	0.2	130*	40*	-2.5*
8	0	0	60	18	-3.0
10	0	0	50	15	-4.0
11*	0.1	0.2	180*	55*	-4.0*
12	0.1	0.2	50	15	-6.5

*Site obscured from the sea by obstacles.

The data in Tables 4 and 5 have been plotted in Fig. 7 showing field strength relative to the fixed site against receiving aerial height above mean sea level on a logarithmic height scale. The line of best fit has been drawn for the measurements at the 12 sites considered to be free from obstruction. It indicates a 3 dB increase in field strength for each doubling of the receiving aerial height. Insufficient measurements are available to give confidence in this curve and the extrapolation above receiving aerial heights of more than 180 ft (55 m) may well be in error.

It has been thought of interest to correct the measurements obtained from the 5 fixed sites, with their wide variation in height above mean sea level, to a common receiving aerial height. Assuming the curve in Fig. 7 applies to all sites, it has been used to reduce the measured results to the field strengths to be expected at 30 ft (9.1 m) above mean sea level. The height gains are given in Table 6, together with the corrected field strengths derived from values in Table 3.

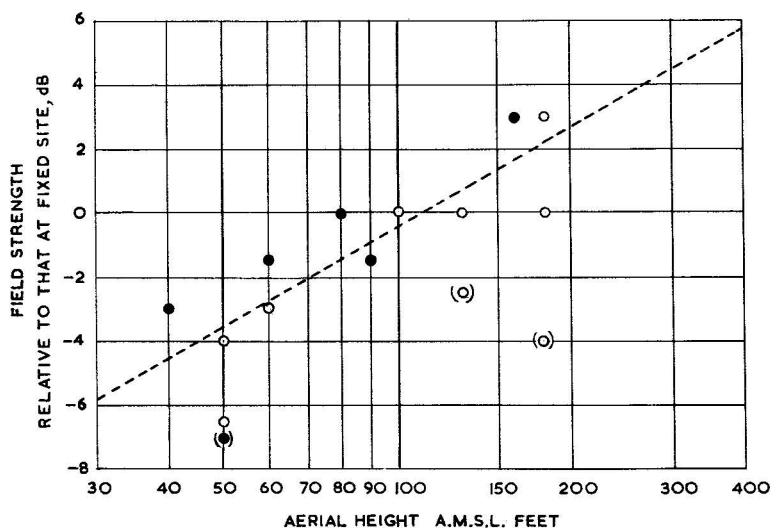


Fig. 7 - Variation of field strength (187 Mc/s) with receiving aerial height above sea level

- = Happisburgh area
- = Flamborough area
- () = Site obscured from the sea by obstacles

The corrected field strength values for a receiving aerial height of 30 ft (9.1 m) above mean sea level given in Table 6 are plotted in Fig. 8 on a linear distance scale and in Fig. 9 on a logarithmic distance scale. The curves for both laws fit the corrected field strength values reasonably well. It is of interest to note that the inverse power law (approximately inverse fourth power) (Fig. 9) gives better agreement with the 1% values while the exponential law (with negative index) (Fig. 8) gives very good agreement with the 0.1% values and with the three 10% values.

If the corrected values shown in Fig. 9 are compared with the measured values shown in Fig. 4 it will be seen that there is almost a constant difference of approximately 6 dB.

TABLE 6

Band III Oversea

Measurements Corrected for Receiving Aerial Height
of 30 ft (9.1 m) a.m.s.l.

Site	Distance from Transmitter	Aerial Height a.m.s.l.		Height Gain	Field Strength, dB rel. 1 $\mu\text{V}/\text{m}$ for 1 kW e.r.p. at 30 ft (9.1 m) a.m.s.l.		
		km	ft		0.1%	1%	10%
Happisburgh	198		80	24	-4.5	49.5	38.5
Flamborough Head	365		180	55	-8.0	42.0	18.5
Newton-by-the-Sea	543		100	30	-5.5	31.5	4.5
Bridge of Don	690		60	18	-3.0	24.5	-2.0
Lerwick	950		330	101	-10.5	11.5	-21.5

5. COMPARISON OF BAND III OVERSEA RESULTS WITH THE RESULTS OF EARLIER EXPERIMENTS

5.1. Comparison with Band II Over the Same Paths

The field strength/distance curves shown in Fig. 5 are replotted in Fig. 10, together with the curves derived from previous measurements¹ made on 94.35 Mc/s over the same paths during the period between July 1954 and September 1955. The actual measured values at each site for certain fixed percentage times and for both frequencies are compared in Table 7.

TABLE 7

Comparison of Oversea Propagation, 94.35 Mc/s and 187 Mc/s

Site	Distance from Transmitter		Frequency	Measured Field Strength (dB rel. 1 $\mu\text{V}/\text{m}$ for 1 kW e.r.p.)			Band III relative to Band II (dB)		
	miles	km		0.1%	1.0%	10%	0.1%	1.0%	10%
Happisburgh	123	198	94.35	35.0	30.25	22.6	+19.0	+12.75	+5.4
			187	54.0	43.0	28.0			
Flamborough Head	227	365	94.35	33.8	22.8	9.9	+16.2	+3.7	-0.9
			187	50.0	26.5	9.0			
Newton-by- the-Sea	338	543	94.35	26.5	8.4		+10.5	+1.6	
			187	37.0*	10.0				
Bridge of Don	429	690	94.35	20.0	-5.5*		+7.5	+6.5	
			187	27.5	1.0				
Lerwick	591	950	94.35	23.3	-7.0*		-1.3	-4.0	
			187	22.0	-11.0				

*Extrapolated

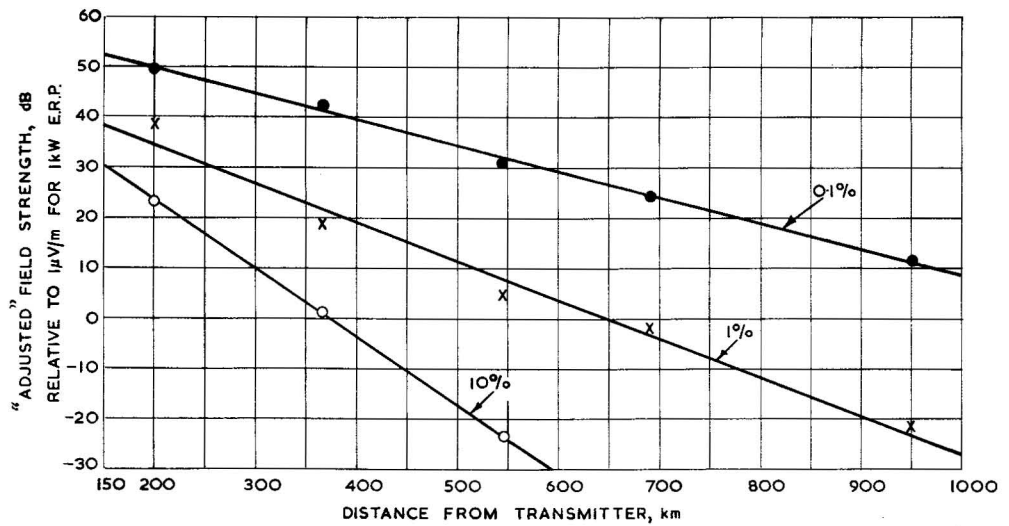


Fig. 8 - Band III overseas: variation of field strength at 30 ft (9.1 m) a.m.s.l. with distance for fixed percentage times - exponential law

● = 0.1%
 X = 1%
 ○ = 10%

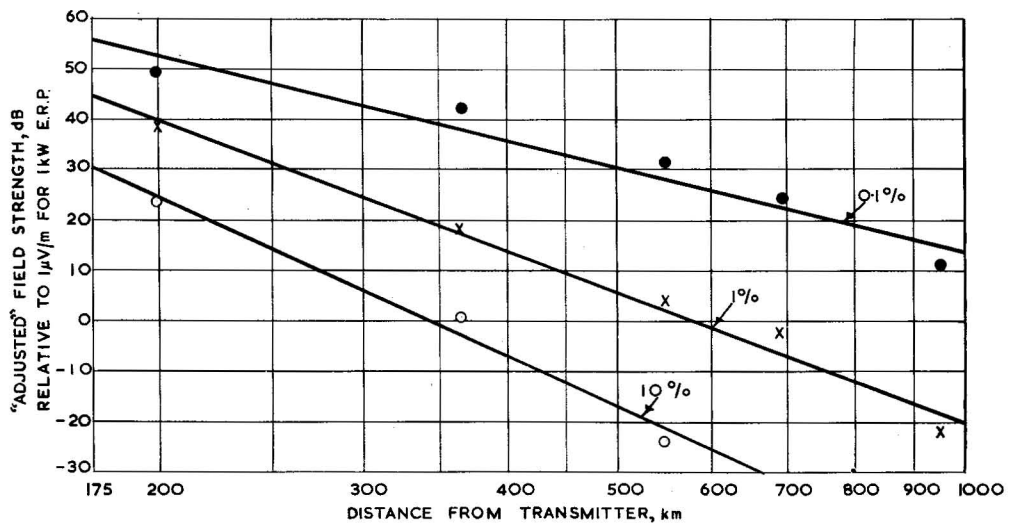


Fig. 9 - Band III overseas: variation of field strength at 30 ft (9.1 m) a.m.s.l. with distance for fixed percentage times - inverse power law

● = 0.1%
 X = 1%
 ○ = 10%

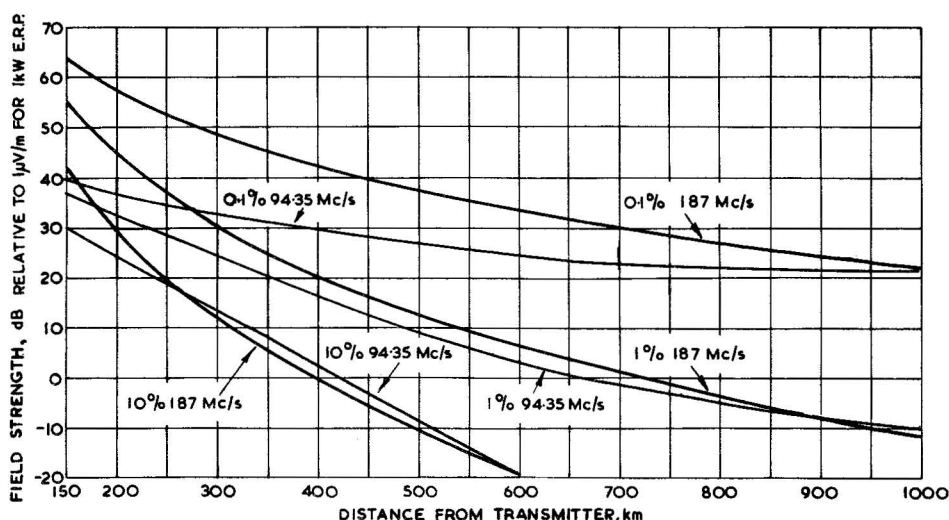


Fig. 10 - Comparison of overseas field strength/distance curves, Band II and Band III

Tropospheric conditions may well have been different during the periods of the two experiments but the comparison points to an increase in field strength received on Band III especially for the smaller percentage times and over the shorter paths.

5.2. Comparison with Band III Overland Results

The field strength/distance curves have again been replotted in Fig. 11, together with the curves derived from the Band III overland measurements published in an earlier Research Department report.² The longest path over which the land measurements were made was 294 miles (473 km) and therefore the comparison can only be made up to this distance.

It will be seen that the attenuation over sea paths is less by some 12 dB to 15 dB than that over land at distances of 200 km (124 miles). The difference between overland and overseas becomes progressively less with increasing distance and increasing percentage time. It must be noted, however, that the Band III overland curves are derived from fixed site measurements but have been adjusted with their appropriate s.v.f.s. These curves therefore represent the field strength to be expected at an average receiving site for the appropriate percentage time. If the overseas field strength/distance curves are reduced by the 6 dB as suggested by the Happingburgh and Flamborough Head s.v.f. measurements, the attenuation overseas is still significantly less than that overland for the shorter distances.

It will be noticed in Fig. 11 that the difference between the 1% and 10% time curves is similar for both overland and overseas experiments and increases with distance. These differences are in contrast to the C.C.I.R. Los Angeles 1959, 40-600 Mc/s curves which suggest a difference of about 10 dB, constant from 200 km onwards. The 1% and 10% measured differences are shown in Table 8 for both the overland and overseas experiments.

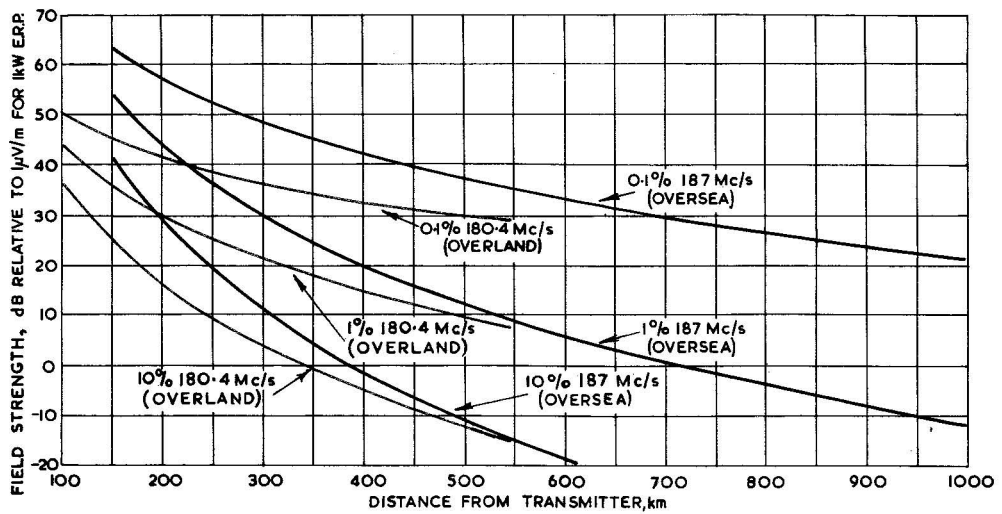


Fig. 11 - Comparison of Band III field strength/distance curves, overland and overseas paths

TABLE 8

Depth of Fading 1% to 10%
Band III

Site	Transmitter	Distance from Transmitter		Difference in dB between 1% and 10% Curves
		miles	km	
Mursley	Sutton Coldfield	62	100	5.0
Ottringham	Pontop Pike	107	172	13.0
Kingswood	Sutton Coldfield	114	183	13.0
Happisburgh	Scheveningen	123	198	15.0
Dorset Head	Pontop Pike	133	214	13.5
Beddingham	Sutton Coldfield	147	237	15.5
Mursley	Pontop Pike	210	338	18.5
Flamborough Head	Scheveningen	227	365	17.5
Kingswood	Pontop Pike	261	420	19.0
Beddingham	Pontop Pike	294	473	21.5
Newton-by-the-Sea	Scheveningen	338	543	28.0*

*Taken from extrapolated values.

6. CONCLUSIONS

The investigations described in this report were conducted over sea paths at a frequency in Band III of 187 Mc/s. The slopes of the field strength/distance curves derived from the measurements decrease with decreasing percentage time, implying a decreasing influence of distance on the received field strength under conditions of abnormal propagation.

The field strength received over a long oversea path tends to increase with the height of the receiving aerial and to decrease with increasing distance inland.

Field strengths received on oversea paths in Band III are higher than those received in Band II (for distances up to 435 miles (700 km)) especially for the low percentage times.

The differences between the 1% and 10% time field strengths measured during this experiment compare with the long distance overland propagation tests on Band III in that the differences increase with increasing distance.

7. ACKNOWLEDGEMENTS

The B.B.C. acknowledges with grateful thanks the facilities most willingly provided by the Netherlands Postal and Telecommunications Services and, in particular, by the staff of Scheveningen Radio who were responsible for installing and maintaining the transmitting system.

Thanks are also due for the assistance and facilities given by the Senior Meteorological Officer and technical staff at Lerwick Observatory. Acknowledgement is also made to the Ministry of Transport for permission to use its coastguard stations as receiving sites and to the unfailing help given by the coastguard officers at these sites.

8. REFERENCES

1. "Final Report on the Long Distance Propagation of a Very High Frequency (94.35 Mc/s) Over the North Sea, 1st July 1954-30th September 1955", Research Department Report No. K-107/2, Serial No. 1956/40.
2. "Long Distance Overland Propagation Measurements at 180.4 Mc/s", Research Department Report No. K-140, Serial No. 1959/23.
3. Documents of the C.C.I.R. VIIIth Plenary Assembly, Warsaw 1956, Vol. 1, Study Programme 55 (V).
4. "A V.H.F./U.H.F. Field Strength Recording Receiver", Research Department Report No. G-056, Serial No. 1955/13.
5. Document 64, C.C.I.R. Meeting of Experts, Cannes 1961.

APPENDIX I

SITE VARIATION FACTOR MEASUREMENTS

Site Variation Factor (S.V.F.) - Measurements Made in Happisburgh Area
Transmission from Scheveningen - Band III (187 Mc/s)

Test No.	Site Location	Grid Ref. (100 km square TG)	Site Height a.m.s.l.		Distance from Fixed Site		Distance from Coast in Direction of Transmitter		Field Strength		Comparison of Field Strength of Temporary with Fixed Site	Site Details
			ft	m	miles	km	miles	km	Temporary dB	Fixed dB		
1	Stow Hill	323359	130	40	4.2	6.8	0	0	+11.5	+8.5	+3.0	Open site on cliff edge.
2	Crosthwait	380296	50	15	3.1	5.0	10.1	16.3	+10.0	+10.0	0	Some power lines and trees in vicinity.
3	North of Grub St.	375310	40	12	0.4	0.6	1.7	2.7	+12.5	+13.5	-1.0	Rising ground, trees and buildings at $\frac{1}{2}$ -mile.
4	Mundesley	317365	60	18	4.7	7.6	0.1	0.2	+10.0	+11.5	-1.5	Near cliff edge, ground rising approximately 10 ft in front of aerial.
5	Marl Point	290383	200	61	6.7	10.8	0.7	1.1	+21.0	+22.5	-1.5	Near cliff edge, some power lines.
6	Cart Gap	398300	30	9	1.7	2.7	0.1	0.2	+5.5	+7.0	-1.5	Near cliff edge, ground rising 15 ft at 100 yd in front of aerial.
7	Brumstead Common	367266	30	9	3.2	5.2	8.7	14.0	+6.5	+8.5	-2.0	Very gradual slope to some trees at 200 yd in front of aerial.
8	Happisburgh Common	363289	30	9	1.9	3.1	7.0	11.3	+9.5	+12.5	-3.0	Open site.
9	Ruddrums Gap	354338	10	3	1.7	2.7	0	0	+7.5	+10.5	-3.0	Some bungalows in front of aerial.
10	Ridlington	352312	50	15	1.4	2.3	5.0	8.0	+5.0	+9.0	-4.0	Open site.
11	Walcott Cross Roads	361313	50	15	1.0	1.6	3.9	6.3	+5.0	+10.0	-5.0	Open site.
12	Paston Street	319350	100	30	4.1	6.6	2.5	4.0	+4.0	+9.0	-5.0	Some power lines and farm buildings behind aerial.
13	Beeston	381226	60	18	6.2	10.0	13.1	21.1	+6.0	+12.0	-6.0	Wood at 150 yd in front of aerial.
14	Sea Palling	430274	20	6	4.3	6.9	0.2	0.3	+0.5	+7.5	-7.0	Some buildings and high sea wall at 200 yd in front of aerial.
15	Castle Farm	421280	20	6	3.6	5.8	0.6	1.0	+2.0	+9.5	-7.5	Open site, high sea wall and buildings at $\frac{1}{2}$ -mile in front of aerial.
16	P.O. Alby	210340	120	37	10.4	16.7	19.4	31.2	+13.5	+21.0	-7.5	Trees at 300 yd in front of aerial.
17	Workhouse Corner	355206	30	9	6.9	11.1	11.6	18.7	+5.0	+16.0	-11.0	Near power lines and trees.
18	Westwick	279257	90	27	7.1	11.4	16.6	26.7	-3.0	+10.0	-13.0	Well wooded, large trees at 100 yd.
19	Drabblegate	200281	40	12	11.2	18.0	22.2	35.7	+9.0	+23.5	-14.5	Rising ground all round site, some trees and power lines.
20 Fixed Site	Dead Man's Grave Happisburgh	305324 376317	120 50	37 15	4.4 -	7.1 -	9.9 -	15.9 -	+4.0	+19.0	-15.0	Open site.
									Site Variation Factor			
									-5.3 dB			

(Field strengths are expressed in dB relative to 1 μ V/m for 1 kW e.r.p.)

SITE VARIATION FACTOR MEASUREMENTS

Site Variation Factor (S.V.F.) - Measurements Made in Flamborough Head Area
Transmission from Scheveningen - Band III (187 Mc/s)

Test No.	Site Location	Grid Ref. (100 km square TA)	Site Height a.m.s.l.		Distance from Fixed Site		Distance from Coast in Direction of Transmitter		Field Strength		Comparison of Field Strength of Temporary with Fixed Site	Site Details
			ft	m	miles	km	miles	km	Temporary	Fixed		
									dB	dB	dB	
1	Flamborough Head Lighthouse	258706	150	46	0.9	1.4	0.3	0.5	+7.5	+4.5	+3.0	Ground falling away towards coast, unobstructed.
2	Flamborough Head Fog Siren	257706	100	30	1.0	1.6	0	0	0	0	0	Ground falling away towards coast, unobstructed.
3	Sands Wood	180667	250	76	7.9	12.7	3.2	5.2	+3.0	+3.0	0	Open country falling away in front of aerial.
4	North Sands	194680	70	21	4.0	6.4	0.1	0.2	-4.0	-4.0	0	Near cliff edge, unobstructed.
5	Sewerby	199688	100	30	3.5	5.6	0.1	0.2	-2.0	+0.5	-2.5	Bungalows between aerial and cliff edge, trees behind aerial.
6	Gransmere	181591	40	12	10.7	17.2	4.0	6.4	-4.0	-1.5	-2.5	Open site.
7	Sixpenny Hill	219719	250	76	1.7	2.7	2.3	3.7	+12.0	+14.5	-2.5	Crest of gradual slope, open country.
8	Hilderthorpe	181662	30	9	5.4	8.7	0	0	-10.0	-7.0	-3.0	Measured at Promenade wall, no obstructions.
9	Nafferton Wold	049615	280	85	13.7	22.1	12.3	19.8	-3.5	0	-3.5	Belt of large trees in front of aerial.
10	Barmston	171595	20	6	9.1	14.6	0	0	-3.0	+1.0	-4.0	Near low cliff edge.
11	Beacon Hill	224693	150	46	2.1	3.4	0.1	0.2	-2.5	+1.5	-4.0	Quarry immediately in front of aerial with hill on far side.
12	Wilsthorpe	170643	20	6	6.4	10.3	0.1	0.2	-12.5	-6.0	-6.5	Power lines 100 yd in front of aerial.
13	Flixton Wolds	050771	500	152	12.6	20.3	10.6	17.1	-4.5	+2.5	-7.0	Undulating, falling away in front of aerial.
14	The Crofts	216701	180	55	2.1	3.4	1.0	1.6	-13.5	-6.0	-7.5	Thick wood 200 yd in front of aerial.
15	Speeton Field	150733	340	104	6.0	9.7	4.6	7.4	-0.5	+7.5	-8.0	Open country.
16	Crab Rocks	197737	310	94	3.3	5.3	4.1	6.6	0	+8.0	-8.0	Open country.
17	Burton Fleming	089717	150	46	9.7	15.6	6.7	10.8	-5.5	+4.0	-9.5	Ground rising to 300 ft at 2½ miles in front of aerial.
18	Nafferton	060580	40	12	14.4	23.2	12.2	19.7	-5.0	+4.5	-9.5	Flat open country with trees at 1 mile in front of aerial.
19	Easton	150680	50	15	6.5	10.5	2.2	3.5	-2.0	+14.0	-16.0	Ground rising all round site, large trees very close but not directly in front of aerial.
20	Reighton Sands	140763	100	30	7.1	11.4	7.1	11.4	-10.5	+14.0	-24.5	Bungalow town, high ground at 2 miles in front of aerial.
Fixed Site	Flamborough Head	247719	150	46	-	-	-	-	Site Variation Factor		-5.8 dB	

(Field strengths are expressed in dB relative to 1 μ V/m for 1 kW e.r.p.)

APPENDIX II

Comparison of Band III Oversea Results with
C.C.I.R. (Cannes 1961) V.H.F. Tropospheric Curves

The C.C.I.R. field strength/distance curves for v.h.f. tropospheric propagation have been reviewed since the preparation of this report. A new series of curves⁵ for the frequency bands I to III was adopted at Cannes in March 1961 by the Meeting of Experts in preparation for the Stockholm 1961 Convention. These new curves give field strength values for 50% and 10% of the time and apply both to land paths and to sea paths in the North Sea area. Two other curves are given for field strength values of 1% of the time; one applies to land paths and the other to sea paths in the North Sea area. Using the sea path curve for the 1% of the time values and the common land/sea curve for the 10% of the time values, these can be compared with the results derived from the overseas measurements as shown in Fig. 5 of this report. Fig. 12 shows the comparison and it will be seen that the field strengths measured during the experiment are in excess of the C.C.I.R. curves.

The field strengths measured during this experiment may have been influenced by the effective heights of the receiving aerials. The field strength/distance curves derived in Section 4.3 for aerial heights of 30 ft (9.1 m) above mean sea level are compared in Fig. 13 with the C.C.I.R. (Cannes 1961) curves for 1% and 10% of the time; the power law relationship plotted in Fig. 9 has been taken. It is seen that the curves derived from this experiment are in excess of the C.C.I.R. curves at the nearer distances, more especially for the 1% time; the 1% curves differ by about 19 dB at 200 km.

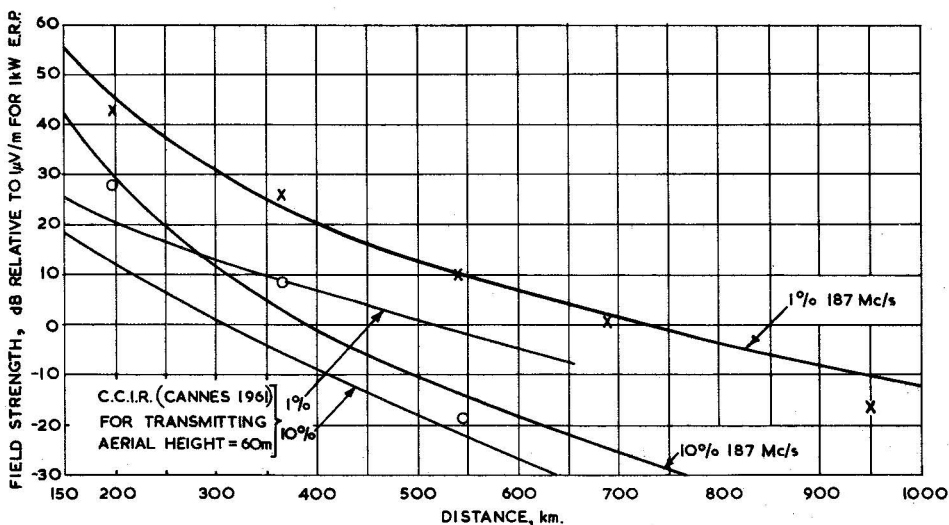


Fig. 12 - Comparison of field strength/distance curves Band III overseas
(measured) with C.C.I.R. (Cannes 1961)

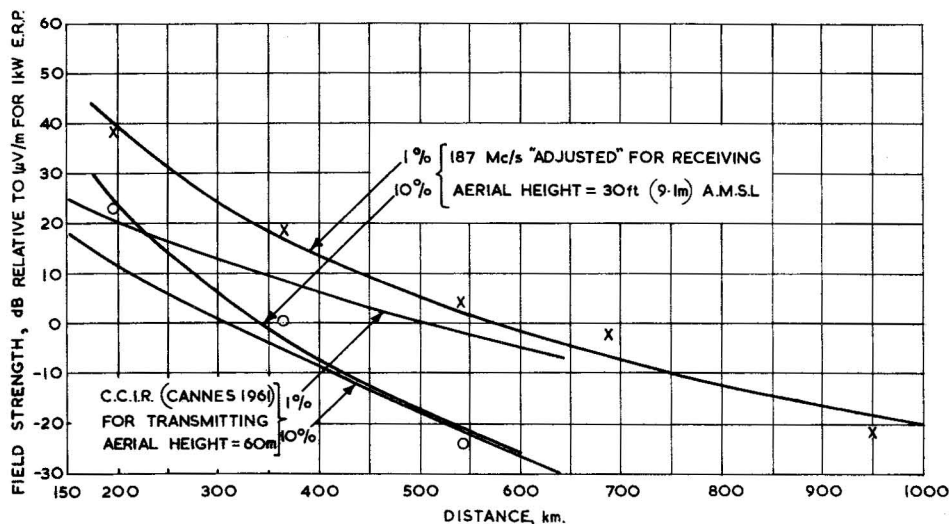


Fig. 13 - Comparison of field strength/distance curves Band III oversea field strength at 30 ft (9.1 m) a.m.s.l. with C.C.I.R. (Cannes 1961)

These remaining differences may well be due to the dependence of field strength upon frequency indicated by the comparison of this experiment and an earlier one¹ over the same paths on Band II in Section 5.1. The field strength measured at Happisburgh for 1% time over a path length of 198 km from Scheveningen was about 13 dB higher on Band III than on Band II transmissions. The C.C.I.R. (Cannes 1961) curves may be weighted by measurements on the lower frequency bands.

Although the Band III curves in Fig. 13 are derived from few measurements, with rather arbitrary correction factors, and the C.C.I.R. curves are based on many measurements, it is possible that separate curves for 1% and 10% time for Band III oversea propagation are warranted.